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THE STRUCTURE OF THE DIATOM VALVE.

By R. P. H. Durkee, Chicago, Ill.

Amongst students of the Diatomaceæ perhaps no one question has provoked more discussion than that of valve construction. Two sides, as in all questions, have been taken, and each with many advocates. The structure of the frustule, that is, that there are to each two valves connected together by what is generally called the "connecting zone," seems to have been quite satisfactorily settled, but just what may be the construction or build of each valve has not, up to this time, so far as I know, been absolutely determined. After a careful study of a series of exceedingly interesting papers on the "Construction of the Diatom Shell," by the Hon. J. D. Cox of Ohio, and published in late numbers of *The American Monthly Microscopical Journal*, I was led to examine very many frustules, both whole and fractured, in the hope that, to my own mind at least, something conclusive might be found. And though my conclusions may not hold good as to every form of diatom, they will be admitted, I think, as to certain forms, and others closely allied, and perhaps it will not be considered too great a stretch of the imagination to believe them to cover the case of all.

It is not my purpose here to quote at length from the writings of the many investigators of "valve construction," but to refer to them briefly, and to such extent only as may be necessary to the subject in hand; nor is it my purpose to discuss the question of the character of the so-called eye-spots, *i. e.*, whether they be elevations or depressions. My only object is to support the hypothesis of Gen. Cox that each valve consists of two plates or laminæ, connected together by a wall-like structure; in its outline sometimes hexagonal, at others circular, and that *each of these plates is whole or imperforate.*

Mr. J. W. Stephenson claims the discovery of the existence of the double plate formation in *Coscinodiscus oculus-iridis*, and Gen. Cox, if I quote him correctly, says, that Mr. Stephenson and himself are agreed as to the double plate formation, and differ in this particular, that while Mr. Stephenson admits that the upper plate has a continuous surface, the lower one is not so, but that there is an opening in the center of each eye-spot located on the second or inner plate. An article in the March number of *The American Monthly Microscopical Journal* on the Structure of Diatoms, written, I presume, by the editor, represents Mr. Stephenson as saying that both plates are perforated, so that whether Mr. Stephenson's claim was that one or both plates were perforated, I do not know, nor as far as my observations are concerned does it make any difference. Of some of the forms examined by Gen. Cox I would refer to those of the families of the Eupodisceæ, the Heliopelteæ, and the Coscinodisceæ, all of which are closely allied in general form, and by him shown to have the same general construction so far as the existence of a double plate formation of the valve is concerned, and the continuity of the plates also; his views on this latter point being based chiefly upon effects produced when viewing the objects by the several methods of reflected light, and which to him have been absolutely convincing.

During the past winter the results of observations of sections of diatoms belonging to the several families above mentioned, carried on by Messrs. Prinz and Van Ermengem, have been made public, the tendency of which would be to support the open plate hypothesis, and also that of those authorities mentioned in *Carpenter's Revelations of the Microscope*, who maintain that such openings exist, through which the living frustule protrudes pseudopodia, and produces the movement familiar to all observers.

Sections of the Cement-stein of Jutland in which the fossil diatoms occur, have been made by these scientists, and have proved to their satisfaction, and that of many others also, that no transparent upper plate whatever exists. Gen. Cox, however, dissents from this view and says, "The doubts as to its value (*i. e.*, their method of investigation), which have been common among students of diatoms, have been based upon the belief that the friable character of the sedimentary rocks is such that it was hardly to be expected that sections thin enough could be successfully made, or that the extremely delicate silicious films of diatoms would withstand the grinding." From this brief recapitulation it would seem as though the question might still be an open one. My own belief was that Gen. Cox's statement was correct, but it was not until the evening of June 25, 1884, that I became convinced of it. At that time, while engaged in the examination of a preparation of the Nottingham earth, I moved into the field a fine specimen of the well-known and beautiful *Heliopelta*. The surface being undulating, the focus so happened to be arranged as to sharply define the highest points. Changing the focus I became aware of a fine crack beginning at the lower margin of the valve, and extending over the segment and running parallel with one of the points of the star to its hyaline center, and it was then, to my great delight, that I found the crack divide and throw out two branches, completely crossing the center and following out their course over the opposite segments. The center was perfect in its frame-work except for the tell-tale cracks, and the question whether there was a film, and if so, a continuous surface, was to me, at least, answered. Though satisfied myself, I was still anxious that others, better skilled in the study, should see the valve, and the next day I submitted it to Dr. H. J. Detmers of the U. S. Department of Agriculture, and to Mr. B. W. Thomas, a life-long student of the Diatomaceæ, both agreeing that the problem was solved beyond the question of a doubt, so far, at all events, as forms of this particular family were concerned, and that, if the conclusions arrived at by Gen. Cox were correct, viz., "that the diatom shell is usually formed of two laminæ; * * * * that when two laminæ are applied together the exterior surfaces of the shell thus formed are approximately smooth," then the question as to all forms was equally settled.

As further evidence, if any was needed, of the existence of the two plates, I would say that Dr. Detmers, in examining the specimen, clearly demonstrated that the upper film only was cracked and the lower layer intact, and the accompanying photographs have been so arranged as to focus, that they exhibit this point.

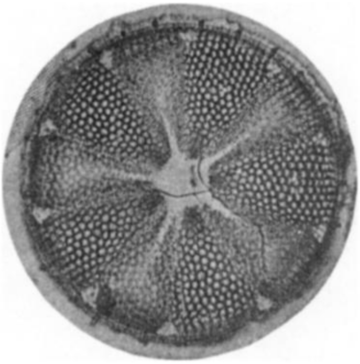
In the hope that so plain a solution of a much vexed question might be of interest to the members of the American Society of Microscopists, I have ventured to submit this paper.

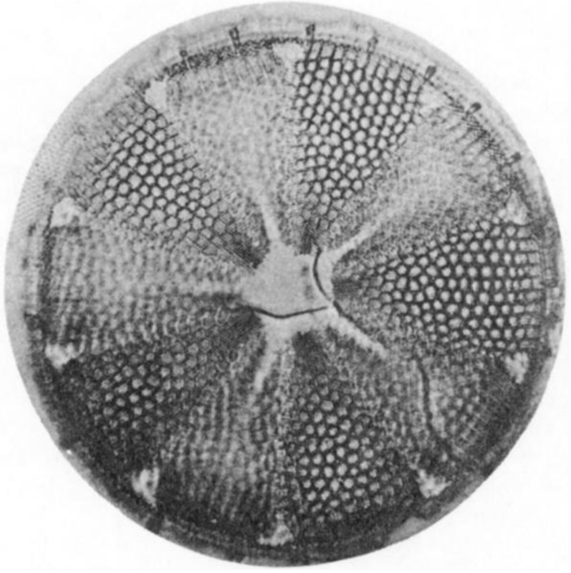
NOTE.—Upon Mr. Durkee's paper Prof. H. L. Smith remarked that, years ago, the central hyaline star of *Heliopelta* had been shown to be a partly horny and partly silicious film by its taking a distinctly brown color when burned. This, of course, had proven that it *is* a film and not a perforation, as Ehrenberg had supposed.

President Cox remarked that he knew by correspondence with Mr. Durkee that the latter did not claim that other proof of the existence of the film had not been given; but only that since so respectable an authority as the *Micrographic Dictionary* still adhered to the ideath at the *Heliopelta* had large perforations both at the center and at the hyaline spaces terminating the rays, it was worth while to put the matter at rest by recording photographic proof which Mr. Durkee had given in his prints of the specimen with a palpable crack through the hyaline part.

Mr. Cox added that he himself had regarded this as hardly an open question any longer, and had directed his own investigations to the smaller "dots" which constitute the common marking of the diatom shell.

PLATE IV.


A.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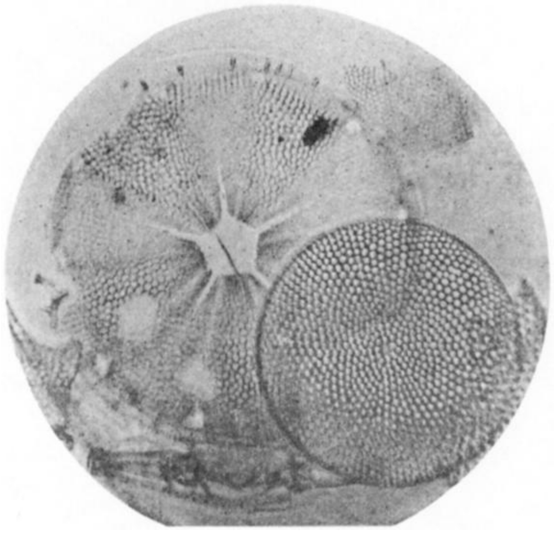
C.

ILLUSTRATIONS OF THE DOUBLE PLATE FORMATION OF THE VALVES OF THE IMPERFORATE CHARACTER OF THE HYALINE STAR IN HELIOPELTA.

Fig. A. Amplification 330 diameters.—Shows the line of fracture very sharply defined, commencing at the lower right hand corner of the segment, crossing it diagonally and passing into the center of the star on the upper side of one of its points, where it divides into two branches, one crossing transversely, the other proceeding in a curve with a generally perpendicular direction, and coming out at the upper edge of the valve. From the transverse branch an off-shoot extends backwards in a line almost parallel with the starting line of fracture, and it will be noticed that all portions of the upper plate of the valve are equally sharp in their outlines with the crack.

Fig. B. Amplification 600 diameters.—Shows the same valve, the objective being so much drawn down as to bring the lower plate more in view, greatly obliterating the line of fracture and almost wholly so the line referred to in Fig. A as an off-shoot from the transverse branch.

Fig. C. Amplification 330 diameters.—Shows another valve on the same slide, in which a fracture running through almost the exact center of the hyaline star demonstrates in connection with the fractures as shown in Figs. A and B the absolutely imperforate character of the star.

In further confirmation of the double plate formation, a view of the valve from the back side (reversing the slide on the stage), shows no crack across the star until the objective has been so far drawn down as to go through the valve, when it is then clearly brought into view. Unfortunately no photograph was taken to illustrate this fact.